REMARKS

Claims 1-41 are pending. Claims 24-36 are withdrawn from consideration as being drawn to a non-elected invention.

Claim Rejections – 35 USC § 112

Claim 38 was amended as proposed by the Examiner to overcome the formality rejection.

Claim Rejections – 35 USC § 103

Claims 1-23, 37 and 39 are rejected as obvious over ASM Handbook: Vol. 2 Properties and Selection: Nonferrous Alloys and Special-Purpose Materials (ASM Vol. 2) alone or with ASM Handbook: Vol. 9 Metallography and Microstructures (ASM Vol. 9).

The Office action asserts there is overlap between the compositions of Claim 1 (and Claim 39) and alloy 2024. and asserts grain size, YS (LT) and $K_{c(a0)}$ recited by the claims are not disclosed by ASM 2 but would be inherent in view of the composition overlap.

The Office action also asserts there is overlap between the compositions of Claim 1 (and Claim 39) and the presently claimed alloy and alloy 2124 and asserts grain size and $K_{c(a0)}$ recited by the claims are not disclosed by ASM 2 but would be inherent in view of the composition overlap.

In particular, Section 5 of the Office Action asserts "*products of identical chemical composition can not have mutually exclusive properties.*" [...] *A chemical composition and its properties are inseparable.*"

It is respectfully submitted that this is an incorrect starting point with respect to at least aluminium metallurgy. Attached is Fig. 41 from a well-known general textbook concerning aluminium metallurgy published by the American Society For Metals (bibliographic date enclosed also) (ATTACHMENT II, *Aluminum Properties and Physical Metallurgy*, p. 181, ed. John E. Hatch, Am. Soc. Metals (1984)). This is considered to represent common general knowledge for the skilled person. This figure shows that for one and the same chemical composition (in the case at hand an 2024 sheet of unknown thickness, the composition is given in the graph itself) that valuable mechanical properties may vary considerably depending on the temper and for example the amount of stretching (5% and no stretching have been illustrated). In this figure the temper conditions T3, T6, T7 and T8 are given.

Thus, the skilled person knows from his common general knowledge that for one and the same chemical alloy composition valuable mechanical properties may vary considerable, being the resultant of thermo and/or mechanical processing.

$K_{C(ao)}$ is a measure for the toughness of the product and is usually measured on panels with a center notch by tearing the panel apart. The panel width can vary, and typical widths are 6" (~ 152 mm), 16" (~ 400 mm) or 30" (~ 760 mm). The wider the panel, the higher the absolute value measured. Therefore, a $K_{C(ao)}$ value is only meaningful when referred with in combination with the relevant panel size (i.e. the width). However, if a material performs better on a panel of a certain size, it also performs better on all other sizes.

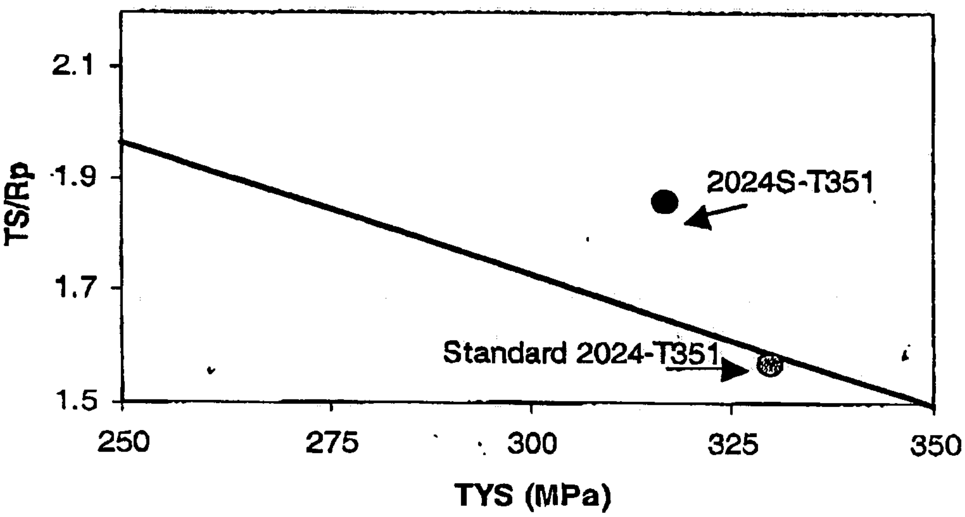
The Office action refers to prior art alloy 2124 in the T851 condition. Only yield strengths have been given, but the fracture toughness as measured by $K_{C(ao)}$ should be very low, even lower than standard 2024, due to the temper condition. Again reference can be made to Fig. 41 discussed above. In this figure for the 5% stretched products both the T3 and the T8 condition (bottom right) have been given. It is immediately clear that the estimated K_C in the T8 condition is about half the value in the T3 condition for the same alloy composition. The presently claimed product is preferably in the T3 or T351 condition, which is complete different from a T8 or T851 condition. The presently claimed combination of properties could not be reached when the product is in the T8 or T851 condition. New Claims 40 and 41 recite T3 and T351 tempers respectively.

To further illustrate the present alloy vs. standard 2024, please find encloses the following figure. In this figure the experimental results have been plot for the 2024S-alloy (being the present alloy) and standard 2024-alloy. Both alloys are in the T351 temper condition. The properties have been measured at sheets of 3.2 mm thickness.

In this graph "TS" stands for Tear Strength, "Rp" stands for yield strength, and "TYS" stands for Tensile Yield Strength. The TS and Rp have been measured in the T-L direction in accordance with ASTM B-871, and TYS has been measured on the Long Transverse direction. The ratio of TS/Rp is believed to be a very good indicator for K_C (thus $K_{app} = K_{CO}$), which can be seen also from Fig. 41 taken from the general textbook discussed above, and are very popular in practical use since they can be measured very fast contrary to the K_C.

In this graph the standard 2024-alloy in T351 condition has a TS/Rp ratio of slightly more than 1.5, which correlates very well with the value of about 1.5 for the 2024-alloy in the T3 condition

with 5% stretch. As known in the art, alloy of a T3 temper condition has been solution heat treated, cold worked, and naturally aged to a substantially stable condition (see our description on page 2, lines 1-3). The further additional digits of Tx51 means that the product has been stress relieved by stretching. Thus "T3 with 5% stretch" represents a T351 temper also.



From this figure it can be seen that the present alloy product has a remarkable improvement in toughness over the standard 2024-alloy, in the same temper and thickness. The difference in toughness properties are to a very large extent the resultant of the microstructure, in particular the grain size, which grain size is obtained by the method described in the application.

Moreover, the Office action asserts ASM Vol. 9 shows micrographs of AA2024-T3, 2024-T6 and 2024-T851 showing the average grain size is $\leq 45\mu m$ which corresponds to the claimed grain size of at least 6. This assertion is respectfully traversed.

Applicant presents the following comments on the "grain-size" related objections. ASTM 6 is indeed equivalent to 45 µm and with a magnification of 500 this results in 22.5 mm. However, each and every grain in Figs. 34 and 35 which have this magnification of 500 are much larger than these 22.5 mm. Fig. 46 (as referenced by the Office action) shows and mentions in the description below this figure: "fragmented grain structure. "There is only one small recrystallised grain" visible; all other grains are not visible, mainly because it is a structure with limited strain and recrystallisation. This clearly means that the structure is not recrystallised and you cannot see the grains. The very

small structure which is visible is the sub-grain structure formed by dislocation networks within the grains. With the etching method applied for this micrograph it is virtually impossible to determine the grain structure. The etching is intended to develop the sub-grain structure. The single grain which can be seen in this micrograph may or may not be smaller than ASTM 6. However, drawing a conclusion from one single grain to an average grain size as mentioned in the present claim is virtually impossible.

Similar arguments hold for micrographs 43 and 44 where again the sub-grain structure is etched using Keller's etch. It is also very difficult or simply impossible to conclude on an average grain size here because you even cannot identify the individual grains. In these cold worked structures which are not fully recrystallised it is extremely difficult to identify grains using the described preparation method. Electro-polishing using a so-called Barker's etch and using polarised light in the light microscope would be the right approach here. Therefore, no one skilled in the art would be able to conclude based upon Figs. 43, 44 or 46 cited by the Office action that the average grain size is above or below 45 μm.

Conclusion

In view of the above, it is respectfully submitted that all objections and rejections are overcome. Thus, a Notice of Allowance is respectfully requested.

Respectfully submitted,

Date: Jan 31, 2003

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ATTACHMENT I - Marked-up Amended Claims

1. A rolled damage tolerant alloy product comprising an aluminum base alloy consisting essentially of (in weight %):

Cu	3.8 – 4.9	
Mg	1.2 – 1.8	
Mn	0.1 – 0.9	
Fe	max. 0.12	
Si	max. 0.10	
Ti	max. 0.15	
Zn	max. 0.20	
Cr	max. 0.10	
impurities	each	max. 0.05
	total	max. 0.15

balance aluminum,

said product having a minimum L-0.2% yield strength of 300 MPa or more, a minimum LT-0.2% yield strength of 270 MPa, a minimum T-L fracture toughness $K_{C(ao)}$ of 100 MPa.$\sqrt{m}$ or more for a 700 mm wide CCT-panel, and having in both L/ST- and LT/ST-sections an average grain size of at least 6 according to ASTM E-112.

2. The product in accordance with Claim 1, wherein the Cu content is in a range of 3.8 to 4.7%.

3. The product in accordance with Claim 1, wherein the Cu content is in a range of 3.9 to 4.6%.

4. The product in accordance with Claim 1, wherein the Mg content is in a range of 1.2 to 1.7%.

5. The product in accordance with Claim 1, wherein the Mn content is in a range of 0.1 to 0.8%.

6. The product in accordance with Claim 1, wherein the product has minimum longitudinal (L)-0.2% yield strength of 360 MPa or more, the minimum 0.2% yield strength in the TL-direction (transverse direction) is 300 MPa.

7. The product in accordance with Claim 1, wherein the product has minimum transverse (TL)-tensile strength of 440 MPa or more and a minimum longitudinal (L)-tensile strength of 475 MPa or more.

8. The product in accordance with Claim 1, wherein the product has minimum L-T fracture toughness $K_{C(ao)}$ of 105 MPa.$\sqrt{m}$ for 700mm wide CCT-panels.

9. The product in accordance with Claim 1, wherein the minimum T-L fracture toughness $K_{C(ao)}$ is 170 MPa.$\sqrt{m}$ or more for 2000mm wide CCT-panels.

10. The product in accordance with Claim 1, wherein the minimum T-L fracture toughness $K_{C(ao)}$ is 175 MPa.$\sqrt{m}$ or more for 2000mm wide CCT-panels.

11. The product in accordance with Claim 1, wherein the grain aspect ratio in both L/ST- and LT/ST-sections is 1:4 or less.

12. The product in accordance with Claim 1, wherein the grain aspect ratio in both L/ST- and LT/ST-sections is 1:3 or less.

13. The product in accordance with Claim 1, wherein the grain aspect ratio in both L/ST- and LT/ST-sections is 1:2 or less.

14. The product in accordance with Claim 1, wherein the product is a sheet product.

15. The product in accordance with Claim 1, wherein the product is a plate product.

16. The product in accordance with Claim 1, wherein the product has an average grain size of 20 to 45 microns.

17. The product in accordance with any one of Claim 1, wherein the product has a range for elongation to fracture in the L-direction from 5 to 35 %.

18. The product in accordance with Claim 1, wherein the product has a range for elongation to fracture in the L-direction from 10 to 25%.

19. The product in accordance with Claim 1, wherein the product has a range for elongation to fracture in the T-direction from 5 to 35 %.

20. The product in accordance with Claim 1, wherein the product has a range for elongation to fracture in the T-direction from 10 to 25%.

21. The product in accordance with Claim 1, wherein the product has an average grain size of according to ASTM E-112 of 6 to 8.

22. A composite comprising the product in accordance with Claim 1, and a cladding on the product, the cladding comprising a higher purity aluminum alloy than said product.

23. A composite comprising the product in accordance with Claim 1, and a cladding on the product, the cladding comprising a member of the group consisting of:

(i) an alloy of the Aluminum Association AA1000 series;

(ii) an alloy of the Aluminum Association AA6000 series; and

(iii) an alloy of the Aluminum Association AA7000 series.

24. (Amended) A method for manufacturing a damage tolerant alloy product, comprising the steps of:

(a) casting an ingot or a slab comprising an aluminum alloy consisting of (in wt. %):

Cu	3.8 – 4.9	
Mg	1.2 – 1.8	
Mn	0.1 – 0.9	
Fe	max. 0.12	
Si	max. 0.10	
Ti	max. 0.15	
Zn	max. 0.20	
Cr	max. 0.10	
impurities	each	max. 0.05
	total	max. 0.15

balance aluminum;

(b) hot rolling the ingot to form an intermediate product;

(c) cold rolling the intermediate product to form a rolled product in both the length and in the width direction with a total cold deformation of more than 60%;

(d) solution heat treating the intermediate product after the cold rolling in at least one direction;

(e) cooling the solution heat treated intermediate product; and

(f) ageing the cooled intermediate product ;

said damage tolerant product having a minimum L-0.2% yield strength of 300 MPa or more, a minimum LT-0.2% yield strength of 270 MPa, a minimum T-L fracture toughness $K_{C(ao)}$ of 100 MPa.√m or more for a 700 mm wide CCT-panel, and having in both L/ST- and LT/ST-sections an average grain size of 20 to 45 microns, and a range for elongation to fracture in the L-direction from 5 to 35 %.

25. The method in accordance with Claim 24, wherein during step (b) the ingot is hot rolled in both the length and in the width direction.

26. The method in accordance with Claim 24, wherein during step (c) the intermediate product is first cold rolled in the one direction with a cold deformation in the range of 20 to 55% and then further cold rolled in the other direction to a rolled product with a total cold deformation of 60% or more.

27. The method in accordance with Claim 26, wherein the process step (c) comprises the sequential steps of:

(c-i) first cold rolling the intermediate product in either the length or the width direction with a cold deformation in the range of 20 to 55%;

(c-ii) first solution heat treating the intermediate product after cold rolling;

(c-iii) tempering the solution heat treated intermediate product to a T3 or a T351-temper;

(c-iv) soft annealing the tempered intermediate product; and

(c-v) second cold rolling of the soft annealed intermediate product in at least the other direction to a final gauge thickness with a total cold deformation of more than 60%.

28. The method in accordance with Claim 27, wherein during process step (c-v) the soft annealed intermediate product is cold rolled in both the length direction and in the width direction.

29. The method in accordance with Claim 27, wherein the hot rolling of the ingot to the intermediate product occurs after homogenization, wherein the homogenization occurs at a temperature of 400 to 505°C.

30. The method in accordance with Claim 27, wherein at least one step selected from the group consisting of the first solution heat treating and the second solution heat treating occurs at a temperature of 460 to 505°C for 5 to 120 minutes.

31. The method in accordance with Claim 27, wherein the at least one member selected from the group consisting of the first solution heat treated intermediate product and the second solution heat treated intermediate product is cooled to a temperature of 175°C or lower.

32. The method in accordance with Claim 27, wherein soft annealing of the cooled intermediate product occurs at a temperature of 300 to 430°C for 0.5 to 12 hours.

33. The method in accordance with Claim 27, wherein between cold rolling passes, the intermediate product is soft annealed at a temperature of 300 to 430°C for 0.5 to 12 hours.

34. The method in accordance with Claim 24, wherein during step (b) the ingot is hot rolled in the length direction and hot rolled in the width direction, with no heating above 488°C between the hot rolling steps.

35. The method in accordance with Claim 27, wherein the total cold deformation ranges from more than 70% to at most 95%.

36 The method in accordance with Claim 24, wherein the average grain size is in the range of 26 to 45 microns.

37. An aircraft skin comprising a sheet or plate of the damage tolerant alloy product of Claim 1.

38. (Amended) An aircraft skin comprising a sheet or plate of the damage tolerant alloy product made by [the method of Claim 24] a method for manufacturing a damage tolerant alloy product, comprising the steps of:

(a) casting an ingot or a slab comprising an aluminum alloy consisting of (in wt. %):

Cu	3.8 – 4.9	
Mg	1.2 – 1.8	
Mn	0.1 – 0.9	
Fe	max. 0.12	
Si	max. 0.10	
Ti	max. 0.15	
Zn	max. 0.20	
Cr	max. 0.10	
impurities	each	max. 0.05
	total	max. 0.15
balance aluminum;		

(b) hot rolling the ingot to form an intermediate product;

(c) cold rolling the intermediate product to form a rolled product in both the length and in the width direction with a total cold deformation of more than 60%;

(d) solution heat treating the intermediate product after the cold rolling in at least one direction;

(e) cooling the solution heat treated intermediate product; and

(f) ageing the cooled intermediate product ;

said damage tolerant product having a minimum L-0.2% yield strength of 300 MPa or more, a minimum LT-0.2% yield strength of 270 MPa, a minimum T-L fracture

toughness $K_{C(ao)}$ of 100 MPa.√m or more for a 700 mm wide CCT-panel, and having in both L/ST- and LT/ST-sections an average grain size of 20 to 45 microns, and a range for elongation to fracture in the L-direction from 5 to 35 %.

39. A damage tolerant alloy rolled product comprising an aluminum base alloy consisting of (in weight %):

Cu	3.8 – 4.9	
Mg	1.2 – 1.8	
Mn	0.1 – 0.9	
Fe	max. 0.12	
Si	max. 0.10	
Ti	max. 0.15	
Zn	max. 0.20	
Cr	max. 0.10	
impurities	each	max. 0.05
	total	max. 0.15

balance aluminum,

said product having a minimum L-0.2% yield strength of 300 MPa or more, a minimum LT-0.2% yield strength of 270 MPa, a minimum T-L fracture toughness $K_{C(ao)}$ of 100 MPa.√m or more for a 700 mm wide CCT-panel, and having in both L/ST- and LT/ST-sections an average grain size of at least 6 according to ASTM E-112.

Please add the following claim.

--40. The product in accordance with Claim 1, wherein the alloy is in a temper selected from the group consisting of a T3 temper.

41. The product in accordance with Claim 1, wherein the alloy is in a temper selected from the group consisting of a T351 temper.--

ATTACHMENT II - *Aluminum Properties and Physical Metallurgy*, p. 181 (Fig. 41), ed. John E. Hatch, Am. Soc. Metals (1984)

ALUMINUM

PROPERTIES AND PHYSICAL METALLURGY

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This book is the collective effort of many experts on aluminum and aluminum alloys.

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high-purity variant of 7075 was superior in the overaged condition (Ref 32). In the instances where toughness was different at the same yield strength, the materials having the lower toughness exhibited a higher proportion of intergranular fracture. The reasons for the different results are tentatively attributed to differences in heating rate to the overaging temperature affecting the width of the precipitate-free zone at grain boundaries. Effects of cold work after solution heat treatment are opposite in 2XXX and 7XXX alloys (Ref 32). Cold work improves the combination of strength and toughness in 2024 (Fig. 41) and decreases it in overaged tempers of 7050 (Fig. 42). The improvement in 2024 is attributed to the refinement of the S' precipitate. This refinement in microstructure provided a simultaneous increase in strength and toughness. The negative effect of cold work in 7050 is attributed to the nucleation of coarse η' precipitates on dislocations, thereby decreasing strength without correspondingly improving toughness.

Because all heat treatable alloys overage with extended heating, the decrease in strength with time must be considered in selecting alloys and tempers for parts subjected to elevated-temperature service. Heat treatable alloys used as electrical conductors, such as 6101 or 6201, are frequently used in overaged tempers because of the higher electrical conductivity associated with more advanced decomposition of the solid solution.

Corrosion Resistance. The extent of precipitation during elevated-temperature aging of alloys 2014, 2219, and 2024 markedly influences

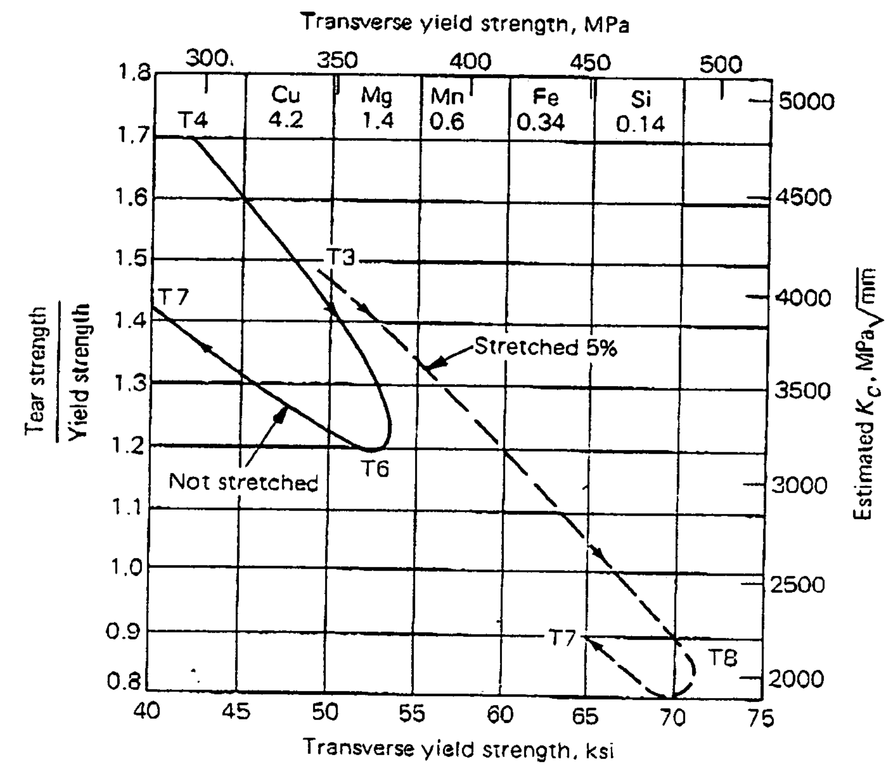

Fig. 41. Effect of stretching and aging on the toughness of 2024 sheet.